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## DUSTING FOR BOLL WEEVIL AND COTTON APHID CONTROL

By Floyd F. Bondy and C. F. Rainwater, Division  
of Cotton Insect Investigations

Dusting with calcium arsenate is the most satisfactory and effective method yet discovered for controlling the boll weevil. However, a serious objection to its use has been the increase in cotton aphids, or plant lice, that often occurs following several applications of calcium arsenate. At times the damage caused by aphids partially offsets the gains secured from weevil control, and some growers have been discouraged from using calcium arsenate because of the fear of aphid damage.

The honeydew secreted by the cotton aphids falls upon the leaves and the open cotton and makes them "gummy," interferes with picking and ginning, and lowers the quality of the lint. A fungus develops in the honeydew and covers the plant with a black coating or "sooty mold." The feeding of the aphids on the plant juices causes the infested leaves to turn yellowish or reddish brown and in severe cases to shed prematurely. Squares and small bolls may also be shed and the larger bolls reduced in size and weight by heavy aphid infestations.

The reasons for the increase in aphids following the use of calcium arsenate are not fully understood. The killing of their natural insect enemies by the arsenical is one of the causes, but other factors are probably involved. Aphids are nearly always present on cotton and at times become injurious when no calcium arsenate is used. Under other conditions, several applications of calcium arsenate may not cause a damaging infestation. The method of application of calcium arsenate apparently has less effect on the abundance of aphids than the quantity applied. Presquare applications of sweetened poison by mopping or spraying cause about the same aphid increase as dusting with equal amounts of calcium arsenate.

Experiments during the past several years have shown that reducing the quantity of calcium arsenate used for boll weevil control is of considerable help in preventing an increase of aphids. It has also been

found that the 8 to 10 pounds of calcium arsenate per acre generally used for weevil control is more than is usually needed, and smaller quantities properly distributed over the plants will give satisfactory control. To overcome the difficulty of getting good distribution of smaller quantities of calcium arsenate with the available dusting machines, the Bureau has recommended adding equal quantities of sulfur or lime to the calcium arsenate (Bureau of Entomology and Plant Quarantine Circulars E-430 and E-431). When sulfur is used the mixture has the additional advantage of controlling the cotton flea hopper and other plant bugs at the same time.

More recent experiments have shown that adding ground derris or cube roots containing rotenone to calcium arsenate or mixtures of calcium arsenate and other materials used for boll weevil control will prevent an increase of cotton aphids. Tests have been made for two years in South Carolina, and a rather large series of experiments were conducted in 1940, by several members<sup>1</sup> of the Bureau of Entomology and Plant Quarantine, in South Carolina, Mississippi, Louisiana, and Texas. The calcium arsenate and derris mixture was also successfully used last season by a group of farmers in eastern North Carolina. In every case the addition of enough ground derris or cube<sup>2</sup> to the calcium arsenate to make one-half of 1 percent of rotenone in the final mixture prevented a damaging increase of aphids and in many cases kept the aphid population lower than in the untreated plots. Boll weevil control was not affected by the addition of the derris. The results have been so uniformly satisfactory and consistent that the information is made available at the present time for the benefit of growers who from past experience expect an injurious aphid infestation to develop following the use of calcium arsenate.

Dusts or sprays containing rotenone have been found to control a number of insects but are not effective against the boll weevil and cannot be substituted for calcium arsenate. Nor is rotenone, in the concentrations generally used, effective against the cotton aphid after heavy infestations have developed. However, a small quantity added to the calcium arsenate each time it is used for boll weevil control will prevent the aphids from increasing to injurious numbers. This is probably due to the fact that at the ordinary strengths used in dusts and sprays the derris is not sufficiently toxic to kill the cotton aphid quickly enough to control a heavy

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<sup>1</sup> The experiments at State College, Miss., were conducted by R. L. McGarr; at Tallulah, La., by R. C. Gaines, M. T. Young, and G. L. Garrison; at Waco, Tex., by K. P. Ewing and R. W. Moreland; and at College Station, Tex., by J. C. Gaines of the Texas Experiment Station.

<sup>2</sup> The roots of several plants contain rotenone and other substances toxic to insects. The more common ones used for insecticidal purposes are derris, cube, and barbasco. Wherever derris is used in this paper these other rotenone-bearing plants may be substituted, since in so far as is now known all are equally effective in preventing an increase of the cotton aphid when they contain the same percentage of rotenone.

infestation, but that the cumulative or residual effects of several applications are sufficient to prevent a light infestation of aphids from increasing. The control of the cotton aphid is secured by holding down the population rather than by controlling a heavy infestation after it has developed. This fact should be emphasized, and derris should be added to the calcium arsenate before the aphids become abundant. After a heavy infestation has developed, dusting with a mixture of nicotine sulfate and lime or calcium arsenate containing 2 or 3 percent nicotine is recommended, although this is not always satisfactory. The use of derris as an aphid preventive overcomes the possibility of aphid damage developing before it is detected and the obnoxious task of applying nicotine sulfate.

Quantity of derris needed.—Experiments conducted to date have shown that the addition of enough derris so that the final mixture will contain one-half of 1 percent (0.5%) of rotenone is sufficient to prevent an injurious aphid infestation from developing under all conditions where it has been tested. Derris is comparatively expensive, and it is hoped that future investigations will show that the quantity may be further reduced, but for the present 0.5 percent of rotenone is recommended. The rotenone content of ground derris root ranges from 3 to 10 percent. Most commercial grades are blended to contain from 4 to 6 percent of rotenone. It is very important to buy ground derris root and mixtures containing derris from a reliable dealer on the basis of a guaranteed percentage of rotenone content.

Diluents for derris.—The rotenone in derris deteriorates or loses its effectiveness when mixed with alkaline materials such as lime or calcium arsenate. How quickly it deteriorates is not yet known. It has been found, however, that a mixture of calcium arsenate and derris retains its effectiveness against cotton aphids for several months and that mixtures prepared before dusting started remained effective throughout the season. Until further information is secured on how long the derris mixtures will remain toxic it is recommended that they be freshly prepared and used only during the season in which they are mixed. Also, it seems advisable at present not to add derris to a mixture of lime and calcium arsenate because both are alkaline. The more inert diluents such as talc, diatomaceous earth, or pyrophyllite, or an acid material such as sulfur are preferable. Sulfur is especially recommended because it will also control the flea hopper and other mirids that may be present at the same time.

Directions for making calcium arsenate-derris mixtures.—It is probable that insecticide manufacturers will place mixtures of calcium arsenate and derris on the market this season. Purchases should be made only from reliable dealers who guarantee the rotenone content. If factory-made mixtures are not readily available, they can be prepared by using a home-made mixer described in Bureau of Entomology and Plant Quarantine Circular E-431. Copies of this circular can be secured from your State experiment station or from the Bureau of Entomology and Plant Quarantine, Washington, D. C. Any standard commercial brands of calcium arsenate and dusting sulfur can be used. The derris root should be finely ground and suitable for dusting.

In making the calcium arsenate-derris mixture at home, three important points should be kept in mind:

- (1) Know the exact percentage of rotenone in the derris.
- (2) Use the correct quantities of each material.
- (3) Mix the materials thoroughly.

An easy way to calculate the quantities of materials needed is on the basis of 100 pounds final weight, which is the usual capacity of a home-made barrel mixer. The number of pounds of material required for making 100 pounds of mixture containing 0.5 percent of rotenone from derris containing different percentages of rotenone are shown in table 1. Sulfur is shown in the table, but any of the other diluents mentioned above may be substituted for the quantities of sulfur shown, or twice the quantity of calcium arsenate indicated may be mixed with the derris and the diluent omitted.

Table 1.--Materials required for 100 pounds of mixture containing 0.5 percent of rotenone, using calcium arsenate, sulfur, and derris containing different percentages of rotenone

Derris containing rotenone, percent	Pounds of derris	Pounds of calcium arsenate	Pounds of sulfur
4.0	12 $\frac{1}{2}$	43 $\frac{3}{4}$	43 $\frac{3}{4}$
5.0	10	45	45
6.0	8 $\frac{1}{2}$	45 $\frac{3}{4}$	45 $\frac{3}{4}$

The mixer should be turned for at least 15 minutes to insure thorough mixing. Good results cannot be expected unless the ingredients are thoroughly mixed.

The finished mixture should be placed in tight containers, such as calcium arsenate drums, and stored in a dry place. Light and moisture hasten deterioration and the materials tend to become lumpy.

Cost of calcium arsenate-derris mixtures.--The present prices of the materials when purchased in quantities are approximately 6 to 8 cents per pound for calcium arsenate, 3 to 4 cents per pound for dusting sulfur, and 25 to 30 cents per pound for derris containing 5 percent of rotenone. The addition of sufficient derris to calcium arsenate to make 0.5 percent of rotenone in the mixture should not increase the cost more than 3 cents per pound above that of calcium arsenate when factory mixed and slightly less when home mixed. When sulfur or other cheaper materials are used in equal proportions with the calcium arsenate, the cost per pound of the mixture will be about the same as of the calcium arsenate. The increase in yields and improvement in grade of cotton from the added control of aphids should pay for the additional cost and leave a profit. Where the cotton flea hopper or other sucking insects are present in injurious numbers the increase

in yields from the addition of sulfur should more than pay for the increased quantity of dust needed per acre.

Quantities to be used per acre.--More calcium arsenate is usually applied per acre than is necessary for controlling the boll weevil. From 4 to 5 pounds per acre, properly distributed, is sufficient under most conditions. The mixture of calcium arsenate and derris should be used at rates which will provide 4 or 5 pounds of the calcium arsenate per acre. If only derris is added to the calcium arsenate, 5 or 6 pounds of the mixture per acre will furnish the necessary amount of arsenical. If equal parts of sulfur or other diluents are added to the calcium arsenate, from 10 to 12 pounds per acre should be used. This quantity contains sufficient bulk and arsenical to give good coverage on large cotton. If the derris is finely ground the mixtures have excellent dusting qualities and give good coverage.

Dusting.--The mixtures of calcium arsenate and derris can be used in the same way as regular calcium arsenate for dusting cotton for boll weevil control. Dusting should begin when 10 percent of the squares are infested and continued at 4- or 5-day intervals until the weevils are brought under control or a crop of bolls is matured. If rain occurs within 24 hours after dusting, the application should be repeated. Conditions for dusting are best early in the morning or near sunset when the air is calm and the plants are moist with dew. If the air is calm, dusting may be done at any time of day, although the dust sticks better when the plants are moist. Any dusting machine or airplane that is suitable for regular calcium arsenate may be used for applying the mixtures. It is important that a good dust cloud be formed and that the dust reach all parts of the plant. Under ordinary conditions, if dusting is started when first needed, three or four applications will usually reduce the infestation so that dusting may be stopped. The number of applications required depends upon the weevil abundance and seasonal conditions. The most important thing is to examine the cotton regularly and to dust as often as needed until a crop is made. In years when boll weevils are very abundant late applications may be necessary to protect the bolls. The difference between a profit or loss on the cotton crop often depends on controlling the insects. Dust right or not at all.

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